

1 CLAIMS:

2 1. An isolation region forming method comprising:
3 forming openings through first and second masking layers over a
4 substrate, the second masking layer being over the first masking layer;
5 after forming the openings, removing portions of the second
6 masking layer while leaving some of the second masking layer remaining
7 over the substrate; and
8 after removing portions of the second masking layer, forming an
9 insulative material within the etch openings, the insulative material within
10 the etch openings forming at least portions of isolation regions.

11

12 2. The method of claim 1 wherein the first masking layer
13 comprises silicon dioxide and the second masking layer comprises silicon
14 nitride.

15

16 3. The method of claim 1 wherein the substrate comprises
17 silicon and the forming insulative material comprises:
18 thermally growing a first silicon dioxide layer from the substrate
19 within the openings; and
20 depositing a second silicon dioxide layer within the openings and
21 over the first silicon dioxide layer.

1 4. The method of claim 1 wherein the removing portions of the
2 second masking layer reduces a thickness of the second masking layer
3 without moving a lateral periphery of the second masking layer outward
4 from the opening.

5
6 5. The method of claim 1 wherein the removing portions of the
7 second masking layer moves a lateral periphery of the second masking
8 layer outward from the opening without reducing a thickness of the
9 second masking layer.

10
11 6. The method of claim 1 wherein the removing portions of the
12 second masking layer moves a lateral periphery of the second masking
13 layer outward from the opening and reduces a thickness of the second
14 masking layer.

15
16
17
18
19
20
21
22
23

1 7. The method of claim 1 further comprising forming a
2 patterned layer of photoresist over the second masking layer before
3 forming the openings through the first and second masking layers, the
4 forming the openings through the first and second masking layers
5 comprising transferring a pattern from the patterned photoresist to the
6 first and second masking layers, at least some of the photoresist
7 remaining over the second masking layer during the removing portions
8 of the second masking layer.

9
10 8. The method of claim 1 further comprising:
11 forming a patterned layer of photoresist over the second masking
12 layer before forming the openings through the first and second masking
13 layers, the forming the openings through the first and second masking
14 layers comprising transferring a pattern from the patterned photoresist
15 to the first and second masking layers; and
16 removing the photoresist from over the second masking layer prior
17 to the removing portions of the second masking layer.

1 9. An isolation region forming method comprising:
2 forming openings through first masking and second masking layers
3 and into a substrate underlying the first and second masking layers, the
4 second masking layer being over the first masking layer;
5 removing portions of the second masking layer while leaving some
6 of the second masking layer remaining over the substrate; and
7 after removing portions of the second masking layer, thermally
8 oxidizing the substrate within the openings to form an oxide layer within
9 the openings, the oxide layer within the openings forming at least
10 portions of isolation regions.

11
12 10. The method of claim 9 wherein the first masking layer
13 comprises silicon dioxide and the second masking layer comprises silicon
14 nitride.

15
16 11. The method of claim 9 wherein the substrate comprises
17 silicon and further comprising depositing a second silicon dioxide layer
18 within the openings and over the thermally grown oxide layer.

1 12. The method of claim 9 wherein the removing portions of the
2 second masking layer reduces a thickness of the second masking layer
3 without moving a lateral periphery of the second masking layer outward
4 from the opening.

5

6 13. The method of claim 9 wherein the removing portions of the
7 second masking layer moves a lateral periphery of the second masking
8 layer outward from the opening without reducing a thickness of the
9 second masking layer.

10

11 14. The method of claim 9 wherein the removing portions of the
12 second masking layer moves a lateral periphery of the second masking
13 layer outward from the opening and reduces a thickness of the second
14 masking layer.

15

16

17

18

19

20

21

22

23

1 15. The method of claim 9 further comprising forming a
2 patterned layer of photoresist over the second masking layer before
3 forming the openings through the first and second masking layers, the
4 forming the openings through the first and second masking layers
5 comprising transferring a pattern from the patterned photoresist to the
6 first and second masking layers, at least some of the photoresist
7 remaining over the second masking layer during the removing portions
8 of the second masking layer.

9
10 16. The method of claim 9 further comprising:
11 forming a patterned layer of photoresist over the second masking
12 layer before forming the openings through the first and second masking
13 layers, the forming the openings through the first and second masking
14 layers comprising transferring a pattern from the patterned photoresist
15 to the first and second masking layers; and
16 removing the photoresist from over the second masking layer prior
17 to the removing portions of the second masking layer.

1 17. An isolation region forming method comprising:
2 forming a first masking layer over a substrate;
3 forming a second masking layer over the first masking layer, the
4 first and second masking layers having a pattern of openings extending
5 therethrough to expose portions of the underlying substrate;
6 etching the exposed portions of the underlying substrate to form
7 openings extending into the substrate;
8 after etching the exposed portions of the underlying substrate,
9 removing portions of the second masking layer while leaving some of the
10 second masking layer remaining over the substrate; and
11 after removing portions of the second masking layer, forming an
12 insulative material within the openings in the substrate, the insulative
13 material within the openings forming at least portions of isolation
14 regions.

15
16 18. The method of claim 17 wherein the first masking layer
17 comprises silicon dioxide and the second masking layer comprises silicon
18 nitride.

1 19. The method of claim 17 wherein the second masking layer
2 comprises lateral sidewalls along the openings extending through the
3 second masking layer, and wherein the removing portions of the second
4 masking layer displaces the lateral sidewalls away from the openings.

5
6 20. The method of claim 17 wherein the second masking layer
7 comprises a thickness over the first masking layer, and wherein the
8 removing portions of the second masking layer reduces the thickness of
9 at least some of the remaining second masking layer.

10
11 21. The method of claim 17 wherein the second masking layer
12 comprises a thickness over the first masking layer, and wherein the
13 removing portions of the second masking layer reduces the thickness of
14 an entirety of the remaining second masking layer.

15
16 22. The method of claim 17 wherein the removing portions of
17 the second masking layer comprises facet etching the second masking
18 layer.

1 23. The method of claim 17 further comprising:
2 after removing portions of the second masking layer, etching the
3 substrate to extend the openings formed in the substrate further into the
4 substrate.

5
6 24. An isolation region forming method comprising:
7 forming a masking layer over a substrate;
8 forming a pattern of openings extending through the masking layer
9 and into the underlying substrate;
10 after forming the openings, facet etching the first masking layer;
11 and
12 after the facet etching, forming insulative material within the
13 openings extended into the substrate, the insulative material within the
14 openings forming at least portions of isolation regions.

15
16 25. The method of claim 24 wherein the masking layer comprises
17 silicon nitride.

18
19
20
21
22
23

1 26. The method of claim 24 wherein the substrate comprises
2 silicon and the forming insulative material comprises:
3

4 thermally growing a first silicon dioxide layer from the substrate
5 within the openings; and

6 depositing a second silicon dioxide layer within the openings and
7 over the first silicon dioxide layer.

8 27. An isolation region forming method comprising:

9 forming a masking layer over a substrate;

10 forming a pattern of openings extending through the masking layer
11 and into the underlying substrate, the first masking layer having edge
12 regions proximate the openings and having a central region between the
13 edge regions;

14 after extending the openings into the underlying substrate, reducing
15 a thickness of the first layer at the edge regions to thin the edge
16 regions relative to the central region; and

17 forming insulative material within the openings extended into the
18 substrate, the insulative material within the openings forming at least
19 portions of isolation regions.

20

21 28. The method of claim 27 wherein the masking layer comprises
22 silicon nitride.

1 29. The method of claim 27 wherein the substrate comprises
2 silicon and the forming insulative material comprises:

3 thermally growing a first silicon dioxide layer from the substrate
4 within the openings; and

5 depositing a second silicon dioxide layer within the openings and
6 over the first silicon dioxide layer.

7
8 30. The method of claim 27 further comprising forming a
9 patterned photoresist layer over the masking layer, and wherein the
10 forming openings comprises transferring a pattern from the patterned
11 photoresist layer to the masking layer, the reducing the thickness of the
12 silicon nitride layer at the edge regions comprising:

13 removing a portion of the photoresist overlying the masking layer
14 edge regions while leaving another portion of the photoresist overlying
15 the masking layer central region; and

16 after removing the portion of the photoresist, and while said other
17 portion of the photoresist is over the masking layer central region,
18 exposing the masking layer to etching conditions which reduce the
19 thickness of the masking layer at the edge regions.

20

21

22

23

1 31. An isolation region forming method comprising:
2 forming a silicon nitride layer over a substrate, the silicon nitride
3 layer having a pattern of openings extending therethrough to expose
4 portions of the underlying substrate;
5 etching the exposed portions of the underlying substrate to form
6 openings extending into the substrate;
7 after etching the exposed portions of the underlying substrate, wet
8 etching the silicon nitride layer to remove portions of the silicon nitride
9 layer while leaving other portions of the silicon nitride layer over the
10 substrate; and
11 after the wet etching, forming oxide within the openings in the
12 substrate, the oxide within the openings forming at least portions of
13 isolation regions.

14
15 32. The method of claim 31 further comprising:
16 forming a silicon oxide layer over the substrate; and
17 the forming the silicon nitride layer comprising forming the silicon
18 nitride layer over the silicon oxide layer.

19
20 33. The method of claim 31 wherein said other portions of the
21 silicon nitride layer have a thickness of at least about 600Å after the
22 wet etching.

1
2 34. The method of claim 31 the wet etching comprises exposing
the silicon nitride layer to phosphoric acid.
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23

1 35. An isolation region forming method comprising:

2 forming a silicon nitride layer over a substrate;

3 forming a masking layer over the silicon nitride layer;

4 forming a pattern of openings extending through the masking layer

5 to the silicon nitride layer;

6 extending the openings through the silicon nitride layer to the

7 underlying substrate with a first etch, the silicon nitride layer comprising

8 edge regions proximate the openings and having a central region between

9 the edge regions;

10 extending the openings into the underlying substrate with a second

11 etch, the second etch forming a polymer over the edge regions;

12 after extending the openings into the underlying substrate, exposing

13 the silicon nitride layer and masking layer to dry etching conditions to

14 remove the polymer from the edges of the silicon nitride layer and to

15 remove portions of the masking layer while leaving other portions of the

16 masking layer remaining over the silicon nitride layer;

17 after the dry etching, further extending the openings into the

18 substrate; and

19 after the further extending, forming oxide within the openings in

20 the substrate, the oxide within the openings forming at least portions of

21 isolation regions.

22

23

1 36. The method of claim 35 wherein the second etch comprises
2 different conditions than the first etch.

3 4 37. The method of claim 35 wherein the second etch comprises
5 a dry plasma etch utilizing CF₄/HBr and the first etch comprises a dry
6 plasma etch utilizing at least one of CF₄ and CH₂F₂.

7 8 38. The method of claim 35 further comprising:
9 forming a silicon oxide layer over the substrate; and
10 the forming the silicon nitride layer comprising forming the silicon
11 nitride layer over the silicon oxide layer.

12 13 39. The method of claim 35 wherein the dry etching comprises
14 exposing the silicon nitride layer and masking layer to an oxygen-
15 containing gas.

16 17 40. The method of claim 35 wherein the masking layer comprises
18 photoresist and the dry etching comprises exposing the silicon nitride
19 layer and masking layer to an oxygen-containing gas.

20 21 41. The method of claim 35 wherein the dry etching comprises
22 exposing the silicon nitride layer and masking layer to O₂.

1 42. An isolation region forming method comprising:
2 forming a silicon nitride layer over a substrate;
3 forming a masking layer over the silicon nitride layer;
4 forming a pattern of openings extending through the masking layer
5 to the silicon nitride layer;
6 extending the openings through the silicon nitride layer to the
7 underlying substrate, the silicon nitride layer having edge regions
8 proximate the openings and having a central region between the edge
9 regions;
10 extending the openings into the underlying substrate;
11 after extending the openings into the underlying substrate, reducing
12 a thickness of the silicon nitride layer at the edge regions to thin the
13 edge regions relative to the central region; and
14 forming oxide within the openings extended into the substrate, the
15 oxide within the openings forming at least portions of isolation regions.

16
17 43. The method of claim 42 further comprising forming a silicon
18 oxide layer over the substrate, the forming the silicon nitride layer
19 comprising forming the silicon nitride layer over the silicon oxide layer.

1 44. The method of claim 42 wherein a thickness of the central
2 region is substantially unchanged as the thickness of the edge regions is
3 reduced.

4

5 45. The method of claim 42 wherein the reducing the thickness
6 of the silicon nitride layer at the edge regions comprises:

7 removing a portion of the masking layer overlying the silicon
8 nitride layer edge regions while leaving another portion of the masking
9 layer overlying the silicon nitride central region; and

10 after removing the portion of the masking layer, and while said
11 other portion of the masking layer is over the silicon nitride central
12 region, exposing the silicon nitride layer to etching conditions which
13 reduce the thickness of the silicon nitride layer at the edge regions.

14

15 46. The method of claim 45 wherein the etching conditions
16 anisotropically etch the silicon nitride layer.

17

18 47. The method of claim 42 wherein the reducing the thickness
19 of the silicon nitride layer at the edge regions comprises:

20 removing the masking layer; and

21 facet etching the silicon nitride layer to form faceted edges at the
22 edge regions.

1 48. The method of claim 42 further comprising:
2 forming a silicon oxide layer over the substrate;
3 the forming the silicon nitride layer comprising forming the silicon
4 nitride layer over the silicon oxide layer;
5 after forming the silicon nitride layer and extending the openings
6 into the underlying substrate, removing a portion of the silicon oxide
7 layer underlying the silicon nitride layer edge regions to undercut the
8 edge regions; and
9 the reducing the thickness of the silicon nitride layer at the edge
10 regions comprising:
11 removing the masking layer; and
12 facet etching the silicon nitride layer to form faceted edges
13 at the edge regions.

14
15
16
17
18
19
20
21
22
23